AN EFFICIENT SYSTEM FOR SMART ROBO WALK

[1]Tareek Pattewar, [2]Saurabh Modi, [3]Gaurang Jotangiya, [4]Vivek Modi
[1]Assistant Professor, [2]Student, [3]Student, [4]Student
[1]Department of Information Technology,
[1]R. C. Patel Institute of Technology, Shirpur, India

Abstract—Now day's many industries are using robots due to their high level of performance and reliability and which is a great help for human beings. Robotics is a fast growing and interesting field. Robot has sufficient intelligence to cover the maximum area of provided space. Robot should move according to the code assigned and navigate according to the conditions. It has an infrared sensor which is used to sense the obstacles coming in between the path of robot. It will move in a particular direction and avoid the obstacle which is coming in its path. The infrared sensor reading is taken and processed to avoid the obstacles. Obstacle avoidance robot has a vast field of application. They can be used as service robots, for the purpose of household work and so many other indoor applications. The desired goal of this system is to avoid obstacles along its path and move forward.

Index Terms— Artificial Intelligence, Fire Bird V robot, Obstacle Detection, ATmega2560

I. INTRODUCTION

Robotics is the branch of technology that deals with the design, construction, operation and application of robots. The word "robot" was first introduced by the Czech writer, Karel Capek in a 1921 play R.U.R. Isaac Asimov a renowned science fiction writer came up with the word "robots". There are different types of mobile robots which can be divided into several categories consists of wheeled robot, crawling robot and legged robot. Robot has sufficient intelligence to cover the maximum area. Designing autonomous robot requires the integration of many sensors and actuators according to their task. Obstacle avoidance is primary requirement for any autonomous robot. The robot acquires information from its surrounding through sensors mounted on the robot. Various types of sensors can be used for obstacle avoiding. The common used sensing devices for obstacle avoiding are Infrared sensor, Ultrasonic sensor, Colour sensors, Light Sensors. The fire bird V robot has 8 IR proximity sensors. It has a infrared sensor which are used to sense the obstacles coming in between the path of robot. Infrared sensors are extensively used for measuring distances. The disadvantage with the obstacle avoidance system is robot has to stop in front of an obstacle in order to allow for a more accurate measurement. All robots feature some kind of collision avoidance that detect an obstacle and stop the robot short of it in order to avoid a collision. The obstacle avoidance algorithm needs to steer the robot around the obstacle and resume motion toward the original target. In this system, robot doesn't have to stop in front of an obstacle during its navigation. Hence the robots may overcome some of the problems during navigation and it can navigate smoothly during its operation avoiding the collisions.

II. LITERATURE SURVEY

Rakesh Chandra Kumar et al. have studies that infrared sensor which is used to sense the obstacles coming in between the path of ROBOT. It will move in a particular direction and avoid the obstacle which is coming in its path. Autonomous Intelligent Robots are robots that can perform desired tasks in unstructured environments without continuous human guidance. The minimum number of gear motor allows the walking robot to minimize the power consumption while construct a program that can produce coordination of multi-degree of freedom for the movement of the robot. It is found that two gear motors are sufficient to produce the basic walking robot and one voltage regulators are needed to control the load where it is capable of supplying enough current to drive two gear motors for each wheel.

Sumit Badal et al. have presented a Practical Obstacle Detection and Avoidance System. Range information is obtained from stereo images by computing a disparity picture from the image pair and extracting points above the ground plane. Then these points are projected onto the ground plane and an Instantaneous Obstacle Map (IOM) is obtained. The IOM is transformed into a one dimensional steering vector that represents the hindrance associated with steering in a particular direction and then a one dimensional search is performed on the steering vector for an angle with least hindrance. The steering direction and hindrance value are used to set the speed of the vehicle. This system has been implemented on the Mobile Perception Lab (MPL) at University of Massachusetts 256-240 sized images.

Kirit Bhagat et al. have derived that an obstacle avoidance robotic vehicle using ultrasonic sensors for its movement. A micro-controller (AT mega 8) is used to achieve the desired operation. A robot is a machine that can perform task automatically or with guidance. Robotics is a combination of computational intelligence and physical machines (motors).Computational intelligence involves the programmed instructions. The project proposes robotic vehicle that has an intelligence built in it such that it directs itself whenever an obstacle comes in its path. This robotic vehicle is built, using a micro-controller of AT mega 8 family. An ultrasonic sensor is used to detect any obstacle ahead of it and sends a command to the micro-controller. Depending on the input signal received, the micro-controller redirects the robot to move in an alternate direction by actuating the motors which are interfaced to it through a motor.

Iwan Ulrich et al. have studied that each individual image pixel is classified as belonging either to an obstacle or the ground based on its color appearance. The method uses a single passive color camera, performs in real-time, and provides a binary obstacle image at high resolution. The system is easily trained by simply driving the robot through its environment. In the adaptive mode, the system keeps learning the appearance of the ground during operation. The system has been tested successfully in a variety of environments, indoors as well as outdoors.

III. SYSTEM ARCHITECTURE

The main objective of this autonomous robot is to detect and avoid obstacle. This robot is controlled by the IR proximity sensors via DC motor. The robot has to be work in such a way that it will move forward until it detects an obstacle. On detecting an obstacle through the IR sensors, it will turn left or right depending on the amount of IR rays detected by IR sensors respectively.

A. Block diagram

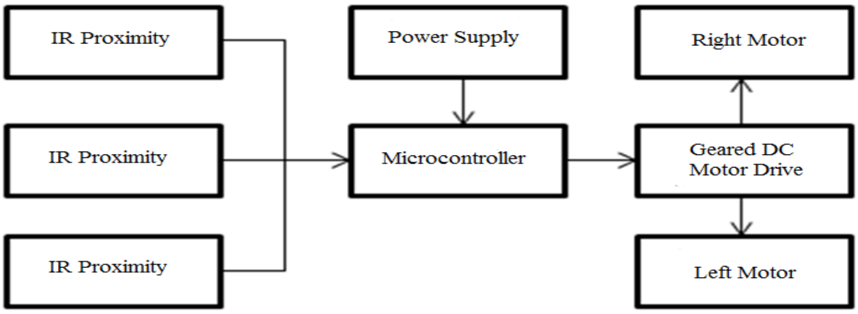

Fig1. Block diagram of Obstacle detection and Avoidance robot

The above block diagram shows the overall co-ordination of the system. The structure consists of motors, IR proximity sensors, 9.6v battery. IR proximity sensor is given as input to the microcontroller and it drives the DC motor using relay board. Fire Bird V's modular architecture allows you to control it using multiple processors such as 8051, ATmega 2560 and ARM7. Modular sensor pods can be mounted on the robot as dictated by intended applications. Precision position encoder makes it possible to have accurate position control. It is powered by high performance rechargeable NiMH battery. Auxiliary power supply provides regulated 11.5V, 1Amp supply. When robot is powered by battery, it can use maximum of 2Amp current while auxiliary supply will provide only 1Amp current. FireBird V robot can sense its current consumption using Hall Effect current sensors.

B. Hardware Requirements

- ATMEGA 2560 controller
- Three analog IR proximity sensors
- Two position encoders
- Current sensing
- Voltage sensing
- Buzzer

IV. HARDWARE DESCRIPTION

A. ATmega2560 Microcontroller

ATmega 2560 is low-power CMOS 8-bit microcontroller based on AVR enhanced RISC architecture. It is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications. Features of ATmega 2560 are:

- 32×8 General Purpose Working Registers
- Most Single Clock Cycle Execution
- On-Chip 2-cycle Multiplier
- In-System Programming by On-chip Boot Program
- Programming Lock for Software Security
- Ultra-Low Power Consumption

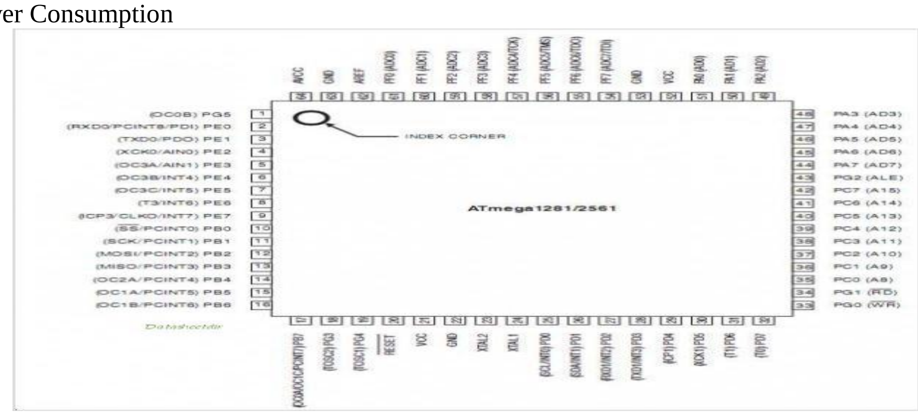

Fig2. ATmega2560 pin diagram

Microcontrollers usually have low-power requirements since many devices they control are battery operated. Microcontrollers are used in many consumer electronics such as car engines, computer peripherals and test or measurement equipment. ATmega 2560 is high-performance, low-power 8-bit AVR RISC-based microcontroller combines 256KB ISP flash memory, 8KB SRAM, 4KB EEPROM, 86 general purpose I/O lines, 32 general purpose working registers, real time counter, six flexible timer/counters with compare modes, PWM, 4 USARTs, byte oriented 2-wire serial interface, 16-channel 10-bit A/D converter, and a JTAG interface for on-chip debugging. By executing powerful instructions in a single clock cycle, the device achieves a throughput approaching 1 MIPS per MHz, balancing power consumption and processing speed.

B. IR Proximity Sensor

Infrared proximity sensors are used to detect proximity of any obstacles in the short range. IR proximity sensors have about 10cm sensing range. These sensors sense the presence of the obstacles in the blind spot region of the Sharp range sensors. Fire Bird V robot has 8 IR proximity sensors. In the absence of the obstacle there is no reflected light hence no leakage current will flow through the photo diode and output voltage of the photodiode will be around 5V. As obstacle comes closer, more light gets reflected and falls on the photo diode and leakage current flowing through the photo diode starts to increase which causes voltage across the diode to fall. IR photo diode consumes about 0.5mA when bright light drives the sensor in to saturation.

C. Buzzer

Robot has 3 KHz piezo buzzer. It can be used for attention seeker for particular events. When the robot is approaching the obstacle it makes a pitch sound and indicates that it detects the obstacle in front of it.

V. OBSTACLE DETECTION AND AVOIDANCE SYSTEM

Initially robot is programmed with forward movement. The robot movement is altered when it counters with the obstacle in its path of movement. The robot is programmed in such a way that, whenever a robot encounters an obstacle, it chooses to move left or right direction in respect to available free space. According to the flowchart, the robot begins to move forward. On moving forward, if an obstacle is detected by IR sensor of the robot, it changes its direction of the movement by tuning either right or left. Robot has an analog infrared proximity sensor. It can be used to detect obstacles. This sensor has a LED that emits infrared light. Infrared light has the interesting property that it bounces on obstacles. On the front of the sensor, beside the LED that emits infrareds, there is a photodiode that is sensible to infrared light. It will vary the output voltage based on the amount of infrared light that bounces back to the sensor. The more infrared light it sees, the closer is the object and the higher output voltage generated by the photodiode. The sensor will provide an analog output voltage that is promotional to the distance of the object it senses. Its analog output will then be fed into analog-to-digital converter of the microcontroller. This value can be used to determine whether or not there are obstacles close to the sensor.

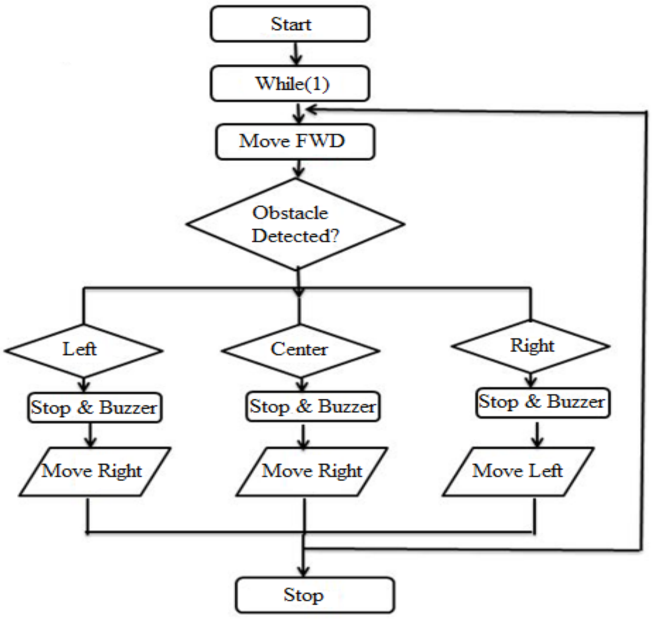

Fig3. Flowchart

VI. PERFORMANCE ANALYSIS

A robot that can successfully detect and avoid obstacles was designed and constructed. It was found that given a number of obstacles, the robot is able to detect and avoid the obstacle with an average accuracy of 79.17%. The equation for calculating the accuracy is given below. The numerator signifies the total number of times the robot was able to avoid the obstacle it faced. The denominator signifies the total number of test cases.

$$Accuracy = \frac{\Sigma(Number\ of\ successful\ Detection\ and\ Avoidance)}{\Sigma(Number\ of\ Test\ Cases)}$$

Table1: Accuracy for specific obstacles

Environment	Types of obstacle	Detected	Avoided	Accuracy
Well-lit	Single solid obstacle	Yes	Yes	100%
Dimly-lit	single solid obstacle	Yes	Yes	100%
Well-lit	Uniform shaped surface	Yes	Yes	100%
Dimly-lit	Uniform shaped surface	Yes	Yes	100%
Well-lit	Wood	Yes	Yes	100%
Dimly-lit	Wood	Yes	Yes	100%
Well-lit	Plastic(Transparent)	Yes	Yes	50%
Dimly-lit	Plastic	Yes	Yes	100%
Well-lit	Tiles	Yes	Yes	100%
Dimly-lit	Tiles	Yes	Yes	100%
Well-lit	Corner shaped surface	No	No	0%
Dimly-lit	Corner shaped surface	No	No	0%

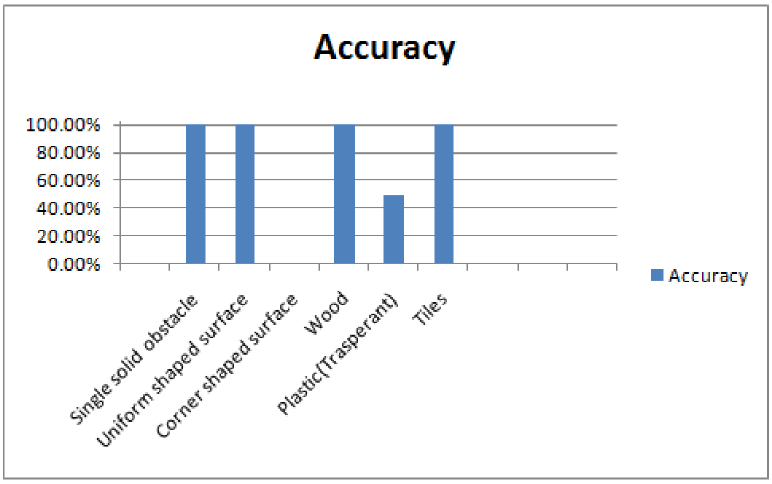

Fig4.Bar chart of Performance Analysis

VII. PERFORMANCE ANALYSIS

With IR proximity sensors our robot is capable to sense the obstacle and by processing the signal coming from the sensor it is perfectly avoiding the obstacle coming in between the path and move forward.

In future, we would like to extend the applications by using Ultrasonic sensor instead of IR proximity sensor for calculating the distance between the obstacle and robot and Image processing techniques for recognizing the object. It also improves the accuracy of system and intelligence of the robot.

REFERENCES

[1] RM.Nachammai, G.Lavanya,N. Mrujool Kansara, R.Gopalakrishnan, "Obstacle Detection and Path Crossover using Fire Bird V Robot", International Journal for Scientific Research & Development, Vol. 3, Fe 2016

[2] Rakesh Chandra Kumar, Md. Saddam Khan, Dinesh Kumar, Rajesh Birua, Sarmistha Mondal, Manas Kr. Parai, "OBSTACLE AVOIDING ROBOT – A PROMISING ONE", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering ,Vol. 2, April 2013

[3] Fire Bird V ATMEGA 2560, Hardware manual, IIT Bombay.

[4] Fire Bird V ATMEGA 2560, Software manual, IIT Bombay.

[5] http://www.nex-robotics.com/products/fire-bird-v-robots/fire-bird-vatmega2560- robotic-research-platform.html

[6] K.Vasavi, M.V.S.Praveen, "Obstacle Detection and Avoidance Autonomous Car", International Journal of Engineering Trends and Technology, Vol. 9, March 2014.

[7] http://www.microchip.com/wwwproducts/en/ATmega2560

[8] http://www.mantech.co.za/datasheets/products/A000047.pdf

[9] Vaghela Ankit, Patel Jigar, Vaghela Savan, "Obstacle Avoidance Robotics Vehicle Using ultrasonic Sensor, Android and Bluetooth for Obstacle detection", International Research Journal of Engineering and Technology, Issue. 02, Volume 03, Feb 2016.

[10] R.Gowtham, "Obstacle Detection and Avoidance Methods for Autonomous Mobile Robot", International Journal of Science and Research, Issue. 01, Volume 05, January 2016.